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# *Habitable Exoplanet (HabEx)*

## *Imaging Mission*

### *Concept Study Planning*

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*Credits: NASA Ames/JPL-Caltech/T. Pyle*

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# Summary

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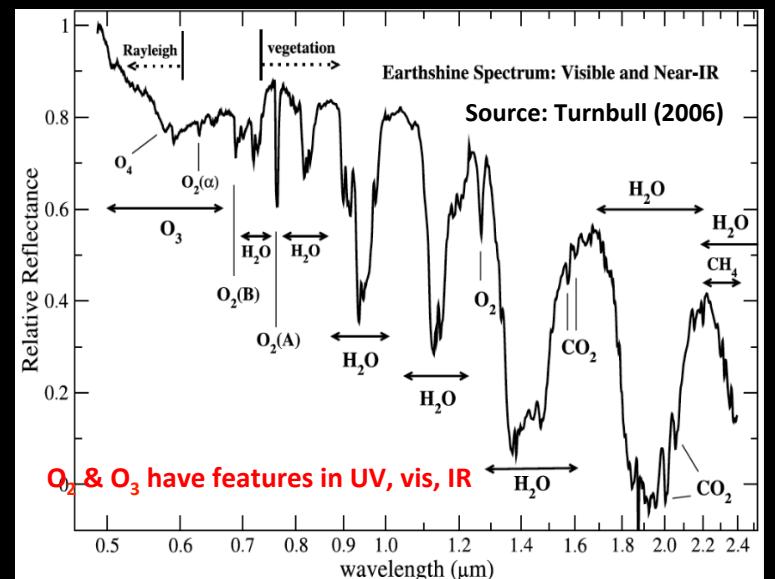
- What is the HabEx concept?
- Why do we need to study the concept?
- What is the current state of the HabEx Science and Technology Definition Team (STDT)?
- What is the current state of the study office team?



# HabEx Science Goals and Concept

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- Overall Concept is open and to be defined by STDT and science community, with support from the study office
  - Many design options a priori possible (on/off axis telescope, segmented or not, internal coronagraph and/or external starshade)
- Primary science goal: search for and characterize potentially habitable worlds
  - Characterize Earth-sized planets in the HZ of nearby stars via direct detection and spectroscopic analysis of their reflected starlight
  - Understand the atmospheric and surface conditions of those exoplanets
  - Specifically, search for water and bio-signature gases on those exoplanets
  - Search for signs of habitability and bio activity in non-Earth-like exoplanets

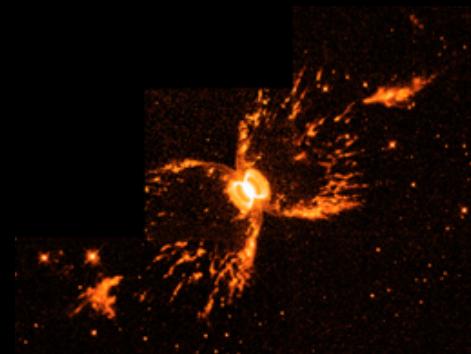




# HabEx Science Goals and Concept

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- Primary Goal Requires a large ultra-stable space telescope with a unique combination of
  - Very high spatial resolution (< 30 mas) and dynamic range ( $\sim 10^{10}$ )
  - High sensitivity / exquisite detectors in the optical (possibly UV and NIR)
- Such a facility will necessarily also provide exceptional capabilities for
  - Characterizing *full* planetary systems, including rocky planets, “water worlds”, gas giants, ice giants, inner and outer dust belts
  - Conducting planet formation and evolution studies
  - Star formation and evolution studies
  - Studying the formation and evolution of galaxies
  - Other general Astrophysics applications
- STDT will direct design team to explore key trades ( $\lambda$ , D, FoV, R)
  - For the primary science goal and for non-exoplanet studies (secondary payload(s))





# Why do we need a concept study?

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- Need to fold in recent advancements in scientific knowledge and high contrast imaging technology:
  - Only recently have the Kepler results constrained  $\eta_{\text{Earth}}$
  - Final analysis of Kepler results and  $\eta_{\text{Earth}}$  value to come mid 2017
  - New powerful post-processing techniques for high contrast imaging (HST/ Ground)
  - More advanced laboratory /field demonstrations of internal coronagraphs and starshade technology over the last 5 years



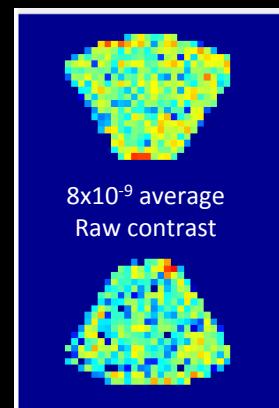
Coronagraph  
Masks



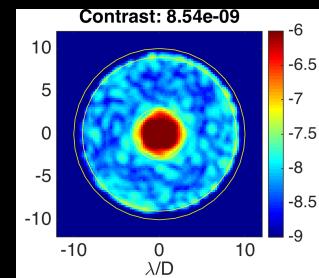
High-Contrast  
Imaging



Deployable  
Starshades



WFIRST-like aperture broad-band lab demos



- Exo-C and Exo-S probes were targeted at \$1B
  - HabEx Concept study will aim to understand how to scale up and build on these studies



# *Current State of STDT Selections*

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- “An embarrassment of riches”: 88 very high profile scientists and technologists applied to the HabEx STDT
- Very competitive selection process led by HQ, in consultation with ExEP, JPL study team and study chairs
- Ensure a community led study by maximizing community membership
- Ensure some continuity with exo-C/ exo-S studies
- Ensure a good balance in terms of expertise between:
  - The various fields of (exo)-planets + disks science and technology
  - General astrophysics themes enabled by the largest diffraction limited optical telescope in space



# STDT Selections

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Community Chair	<b>Cahoy, Kerri (MIT)</b>	Space Systems technology and Xpl spectra
	<b>Domegal-Goldman, Shawn (GSFC)</b>	Bio-signatures and Xpl spectra
	<b>Feinberg, Lee (NASA GSFC)</b>	Picometer wavefront control
	<b>Gaudi, Scott (Ohio State) [Co-Chair]</b>	Xpl Demographics / WFIRST
	<b>Guyon, Olivier (Arizona)</b>	Coronagraph design / Wavefront control
	<b>Kasdin, Jeremy (Princeton)</b>	Starshade and Coronagraph designs
Center Study Scientist	<b>Mawet, Dimitri (Caltech)</b>	Coronagraph design / Disks/ Post processing
	<b>Mennesson, Bertrand (JPL)</b>	Debris disks / High Contrast Imaging
	<b>Robinson, Tyler (UC Santa Cruz)</b>	Atmospheric spectral retrieval
	<b>Rogers, Leslie (Chicago)</b>	Low mass Xpl Interior structure & evolution
Community Chair	<b>Scowen, Paul (Arizona State)</b>	General astro/ UV/ ISM COPAG Chair
	<b>Seager, Sara (MIT) [Co-Chair]</b>	Starshade / Bio-signatures
	<b>Somerville, Rachel (Rutgers)</b>	Star and galaxy formation / theory vs observations
	<b>Stapelfeldt, Karl (NASA JPL)</b>	Disks/ ExEP CS
	<b>Stern, Daniel (JPL)</b>	General astrophysics/ AGNs/ NIR
	<b>Turnbull, Margaret (SETI)</b>	mission design / target selection

CNES Observer: Mouillet, David (IPAG) – CSA Observer: Marois, Christian (NRC Canada)

DLR Observer: Quirrenbach, Andreas (Heidelberg)

*THANKS TO ALL APPLICANTS! WARM CONGRATS TO THE 16<sup>(\*)</sup> HABEX STDT MEMBERS: WELCOME ABOARD !!!  
KICK-OFF MEETING IN SPRING 2016*



# *Status of Study Office Team*

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- Core Team being built as we speak, but most key roles already filled:
  - K. Warfield (Study Manager), B. Mennesson (Study Scientist),
  - D. Breda (Lead Systems Engineer), S. Martin (Lead Instrument Engineer)
  - S. Shaklan and D. Lisman (Coronagraph and Starshade Technology),
  - P. Stahl (MSFC, Optical Design and Development)
  - R. Morgan (“Standards Team” Coordination)
  - Additional contracts to support science yield calculations? Assess impact of prior high precision RV measurements?
- Developing plan to maximize the efficiency of engaging with
  - LUVOIR Team (monthly telecons/ share and exchange engineering resources)
  - Existing Projects / Missions (WFIRST-CGI tech developments, Kepler & LBTI findings)
  - ExEP appointed Exoplanet Standard Definition and Evaluation Team, StarShade Readiness Working Group (SSWG), Segmented Aperture Design and Analysis Group (APD funded in FY16)
  - Industry partners: host HabEx “Industry Day” early in the study
- Preparing for delivery of concept study deliverables to HQ
  - Comments on study requirements and deliverables, due April 29, 2016
  - Deliver initial technology gaps for inclusion in ExEP, SAT/TDEM, and APRA Proposal Cycles, due June 30, 2016
  - Detailed 3 year study plan and schedule of MS delivery, August 26, 2016